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(54) **Feeding Filamentary Material**

(57) A strapping machine for wrapping filamentary material around a package includes co-operating rotary members for feeding, or back-feeding, the filamentary material and means associated with one of the rotary members for generating electric pulses indicative of rotation of the member. When the roller associated with the pulse generator is brought to rest, by tightening of the material, a discriminator circuit gives a signal for the next operation in a machine cycle to commence.

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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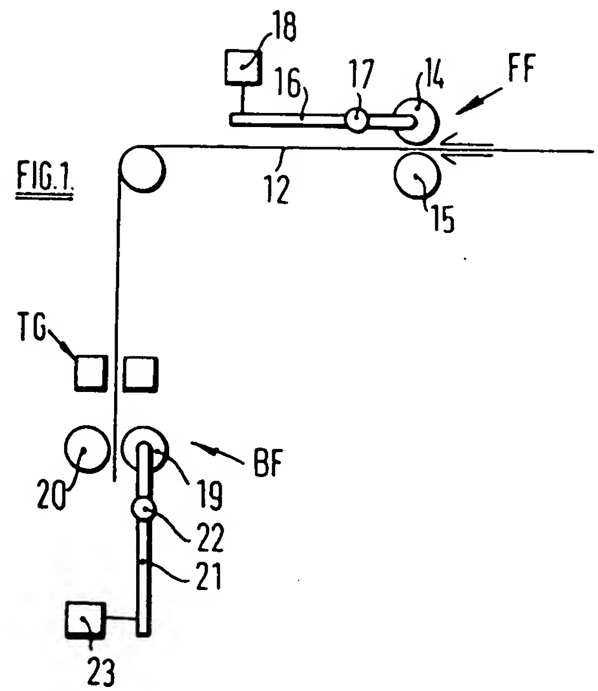


FIG.1.

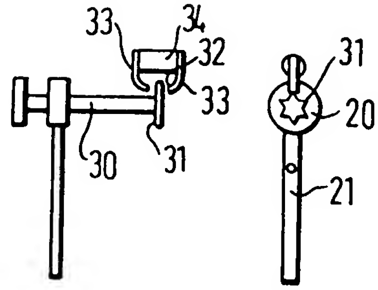


FIG.2.

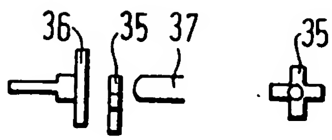


FIG.3.

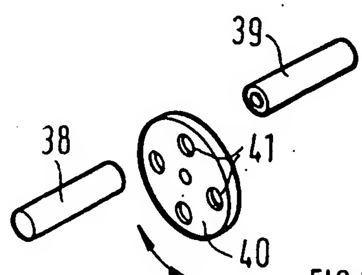
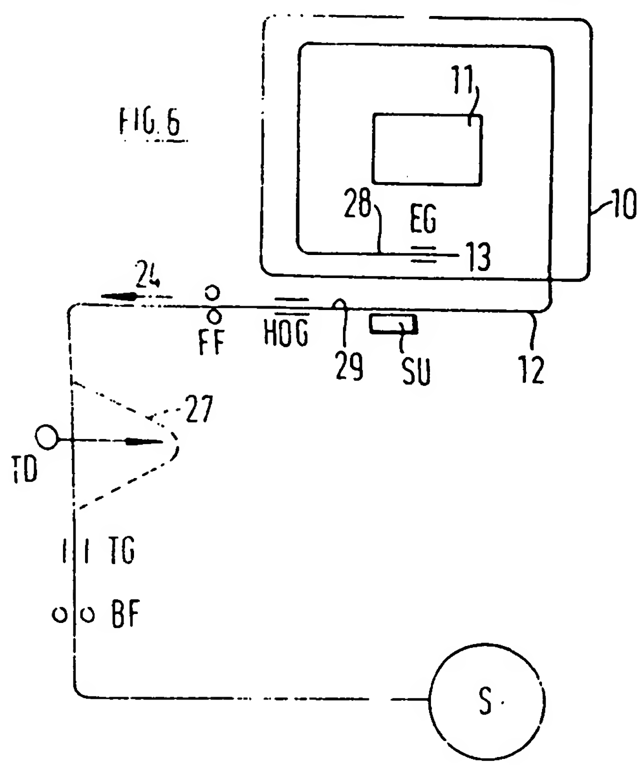


FIG.4.

FIG.6



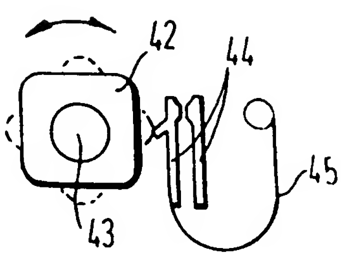


FIG.5.

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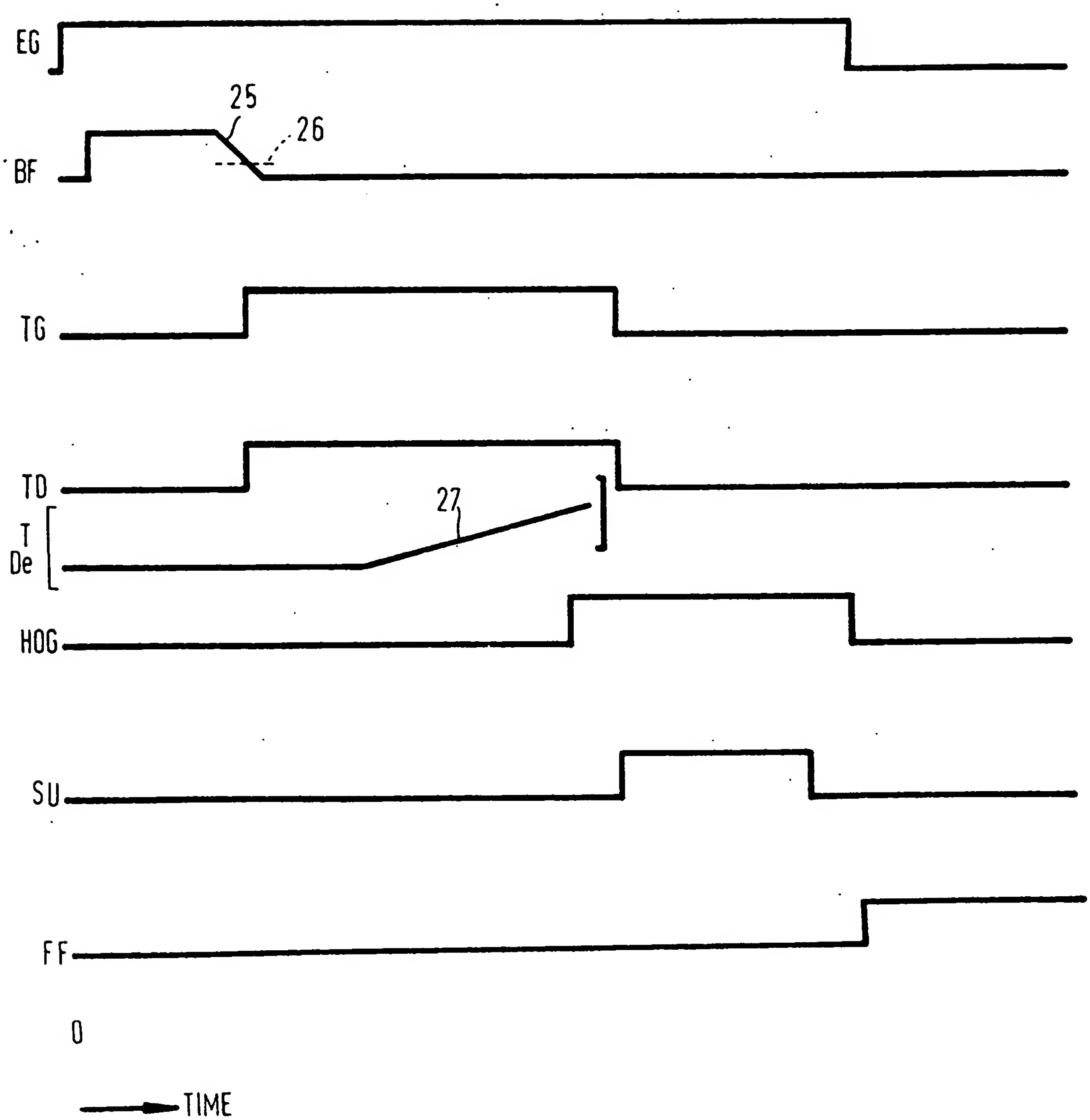
FIG. 7



SPECIFICATION
Strapping Machines

This invention relates to machines for feeding filamentary or sheet material. The invention has been developed in relation to strapping machines of the kind (hereinafter referred to as being of the kind specified) in which a filament is fed from a supply around a frame within which is placed a package to be strapped. The free end of the filament is gripped, the filament is then back-fed to cause it to embrace the package, then tensioned about the package and then adjacent parts of the filament are joined together to complete a tensioned loop about the package. Before, after, or simultaneously with joining said adjacent parts of the filament, the filament forming the loop is severed from the supply. The filament may be metal wire or plastics strap. If the filament is wire then the adjacent parts are twisted together. If the filament is a plastics strap the adjacent parts may be heat-sealed or friction-welded together. In strapping machines of the kind specified, the various operations have to be carried out in the correct sequence. In some instances, one operation has to be completed before another is initiated. In particular, the free end of the filament must be gripped before the filament is back-fed and the back-feeding must be completed before the filament is tensioned.

The feeding and back-feeding are effected by rotary members which grip and feed the filament. It is necessary to produce a signal at the end of the back-feeding and currently strapping machines of the kind specified use, for this purpose, centrifugal switches, inertia switches, pneumatic sequencing valves or slipping clutches with timing devices etc. In particular, inertia switches rely on a combination of inertia and friction and are very critical in their operation and have to be re-adjusted every time the speed of operation of the machine changes. It has been found that these arrangements are unreliable. Furthermore, the detection of the end of the back-feeding and the initiation of the next step in the sequence of the strapping machine are carried out by two different items of equipment. The mechanical devices which are used at present are expensive, since they must be precisely made, and the speed of operation of the devices is usually the limiting factor in reducing the cycle time of the machine. Similar problems arise in other machines in which filamentary or sheet material is fed or back-fed.

It is an object of our aspect of the invention to provide a machine for feeding and/or back-feeding filamentary or sheet material and which is an improvement on those at present in use.

According to this aspect of the invention we provide a machine including a rotary member for feeding or back-feeding filamentary or sheet material and means associated with the rotary member for generating electric pulses, or groups of pulses, as the member rotates and detector means for detecting the presence and/or absence of said pulses, or group of pulses, and to provide a signal for the operation of the machine.

It is an object of another aspect of the present invention to provide a strapping machine of the kind specified with reliable means for detecting when an operation of feeding or back-feeding the filament has been completed.

According to this aspect of the invention we provide a strapping machine of the kind specified including a rotary member for feeding and/or back-feeding the filament and means associated with the rotary member for generating electric pulses, or groups of pulses, as the member rotates and detector means for detecting the presence and/or absence of said pulses or groups of pulses, and to provide a signal for the continuation of the machine cycle.

Preferably, the pulses, or groups thereof, when produced act as a "dynamic memory" to provide e.g., an inhibit signal to prevent the effecting of any further step in the machine sequence until the detector has detected the absence of the pulses or groups thereof.

Preferably, said rotary member is one of a pair of cooperating rotary members and is freely rotatable by engagement with the material to be fed, e.g. filament, the other member of the pair being drivable to effect feeding or back-feeding, the arrangement being such that when feeding or back-feeding is completed, the one member comes to rest thus providing a signal for the initiation of further operations of the machine. Thus while the feeding or back-feeding is being effected, the rotary member rotates and produces the pulses or groups thereof. At the termination of the feeding or back-feeding the driven rotary member will skid on the material and the freely rotatable rotary member will come to rest thus terminating the generation of the pulses, or the groups thereof. This termination of generation is detected and provides the signals for the operation of the machine, e.g. the continuation of such operation.

The rotary members of the or each pair may be relatively movable between operative and inoperative positions. Thus, one of the rotary members may be mounted on a pivoted arm operated by a solenoid to move the rotary member between an operative position in which the material is gripped between the rotary members and an inoperative position in which the rotary members are spaced apart to give clearance to the material.

The generation of the electric pulses may be produced in any one of a number of ways. In a first arrangement, the rotary member can be caused to make and break an electrical contact as it rotates, the frequency of the pulses being of the order of 100—200 cycles per minute.

In a second arrangement, the rotary member drives an apertured or slotted member between a light source and a photo-electric cell. The resistance of the cell will vary depending on the light allowed to fall on it and will thus produce pulses when connected in an appropriate circuit.

In a third arrangement, the rotary member drives a toothed disc which varies the inductance of the gap in an electro-magnetic circuit to which a DC voltage is applied, this inductance variation producing the required pulses.

A fourth arrangement is similar to the third arrangement except that a high frequency AC voltage, for example having a frequency of between 20—50 KHz is applied to the electro-magnetic circuit and the rotation of the toothed disc provides a series of groups of pulses instead of a series of single pulses.

In a fifth arrangement, the rotary member drives a slotted or apertured disc interposed between the plates of a capacitor and which varies the capacitance thereof. A high frequency AC voltage is applied to the capacitor and again one obtains a series of groups or pulses.

In any of the above arrangements, conventional circuits will be used to slug the pulses of groups thereof to obtain a reasonably continuous signal and a disciminator circuit will be set at a predetermined level to detect the absence of the pulses or the series thereof.

The invention will now be described in detail by way of example with reference to the accompanying diagrammatic drawings in which:—

Figure 1 is a diagram illustrating the arrangement of feed rollers and backfeed rollers in a strapping machine embodying the invention;

Figures 2 to 5 are diagrams illustrating various means for producing pulses;

Figure 6 is a diagram of the various feed rollers and grippers in a strapping machine embodying the invention;

Figure 7 is a chart showing the sequence of operation of the machine.

Referring first to Figures 1 and 6, the strapping machine comprises a frame 10 within which is located a package 11 to be strapped. A filament 12, which may be metal wire or plastics strapping will, at the end of a previous cycle, have been fed around the frame 10 by forward feed rollers FF until the free end 13 of the filament is detected whereupon the forward feed rollers FF will be disabled. These rollers are shown in Figure 1 at 14 and 15. The roller 15 is driven, by means not shown, and the roller 14 is mounted on an arm 16, pivoted at 17 and movable about the pivot by a solenoid 18. When the rollers 14 and 15 are brought together by the solenoid 18 they grip the filament 12 but when they are moved apart the filament can pass freely between the rollers.

At the end of a preceding cycle, the filament will have been fed as described and if a new cycle is now initiated, the first thing that will happen is that an end gripper EG will grip the free end 13 of the filament. This is indicated by the rise of the line EG in Figure 7 from its datum level at time 0. It will be seen from Figure 7 that at time 0 all the other items of the machine which will be referred to and described below are at their datum levels and are therefore inoperative. Means, not shown, will sense that the end gripper is operative, these means may, for example, be a switch operated by the end gripper. This passes a signal to activate the back-feed rolls BF shown in Figure 1 and comprising a driven roller, a freely rotatable roller 20, an arm 21 on which the roller 20 is mounted, the arm 21 being pivoted at 22, and a solenoid 23 to operate the arm 21 to bring the back-feed rollers into operative relation to grip the filament 12 or to move them to inoperative relation as described for the forward feed rollers FF. The back-feed rollers are operated by driving the roller 19 with the rollers 19 and 20 in their operative relation and the freely rotatable roller 20 is arranged, as will be described below, to produce a series of electrical pulses or groups of pulses. The result of back-feeding will be to tighten the filament 12 around the package 11, back-feeding moving the filament in the direction of the arrow 24 in Figure 6. The back-feeding will continue until the filament is engaged with the package 11. The rollers 19 and 20 will be incapable of tightening the filament further and the roller 19, although it will continue to rotate, will skid on the filament while the roller 20 will come to rest. The coming of the roller 20 to rest will be detected by a discriminator circuit which has been sensing the pulses. The pulses, or groups thereof, will have been slugged to produce a generally constant signal which will decay as indicated at 25 in Figure 7. At a predetermined point in the decaying signal, indicated by the dotted line 26, the discriminator circuit will give a signal for the next operation to commence.

The next operation is for the tension gripper TG to come on to grip the filament as indicated by the line TG in Figure 7 when the discriminator circuit senses the decay in the signal. The tension gripper having gripped the filament at the position shown in Figure 6, the tension device TD then comes on as indicated by that line in Figure 7 and, as indicated in Figure 6, the filament is tensioned about the package as indicated at 27. The tension in the filament is sensed by a tension-detector (not shown) and the increase in signal in this detector is indicated by the inclined line 27 labelled T Det in Figure 7. When the tension reached a predetermined value, the hold-on gripper HOG comes on as indicated by that line in Figure 7 and grips the filament. The end gripper and the hold-on gripper may be aligned. The sealing unit SU is then operated to unite the overlying parts of the filament indicated at 28 and 29. If the filament is plastics strapping then the sealing unit will weld the overlapping parts 28 and 29 by heat-swelling them or by friction welding. If the filament is a wire then the sealing unit will twist the overlapping parts together.

It will be noted from Figure 7 that when the hold-on gripper has come on, the tension gripper TG and the tensioning device come off. The sealing unit is operated for sufficiently long to provide the seal and then hold-on gripper and end gripper come off as shown in Figure 7. At some state the filament forming the loop is severed from the filament in the supply S. This may be

done before, after, or simultaneously with the sealing of the overlapping filament parts together.

As a final step in the cycle, the forward feed rollers became operative as indicated by the line FF in Figure 7 and feed the filament round until the free end 13 reaches the end gripper as before. It will be seen from Figure 7 that the forward feed rollers FF and back-feed rollers BF are not energised at the same time and the solenoids 18 and 23 will be operated accordingly.

As described, it is only the end of the back-feeding which is sensed by the cessation of pulses produced by the back-feeding roller 20. However, if desired, the end of the forward feeding could be sensed by the cessation of pulses produced by the roller 14 during forward feeding. Thus the filament could be caused to come up against an abutment adjacent the end gripper whereupon the roller 15 would skid relative to the filament and the roller 14 would come to rest.

Figures 2 to 5 show various ways in which the pulses, or groups of pulses, can be produced by rotation of the roller 15 or 20.

Referring to Figure 2 the roller 20, mounted on the arm 21 carries a shaft 30 on which is mounted a serrated disc 31. The disc 31 rotates in a gap 32 between the poles 33 of an electro-magnet 34. If a DC voltage is applied to electro-magnet 34, rotation of the serrated disc 31 will provide a series of pulses. If a high frequency alternating voltage is applied to the electro-magnet 34 then rotation of the serrated disc 31 will produce a series of groups of pulses. In either case, the pulses or groups of pulses are produced during back-feeding. When the back-feeding is terminated, the generation of the pulses or groups of pulses ceases and the signal decays as shown at 25 in Figure 7. This is sensed as described and brings on the tension gripper and the remaining steps of operation of the machine.

A similar arrangement could be applied to the forward feed rollers.

In Figure 3, a rotating, cruciform disc 35 rotates between a capacitor plate 36 and a probe 37. The rotation of the disc 35 varies the capacitance of the capacitor consisting of the items 35, 36 and 37 and this variation in capacitance is used, via an appropriate circuit, to produce groups of pulses and the operation is as described in relation to Figure 2.

In Figure 4, a light source 38 is directed at a photoelectric cell 39 and an apertured or serrated disc 40 is interposed between the light source and the photo-electric cell. As shown, the disc has apertures 41. The resistance of the photo-electric cell 39 will vary depending on whether light is falling on it or not and these variations in resistance are, through a suitable circuit, caused to produce pulses upon rotation of the roller 20 which drives the disc 40.

Figure 5 shows a square cam 42 which is rotated about an axis 43 by the roller 20 and makes and breaks two contacts 44 which are urged together by a spring 45. Once again, as the roller 20 rotates the cam is rotated thus making and breaking the contacts 44 which will provide pulses. When the pulses stop, the discriminator circuit passes a signal to cause the machine to carry on with its sequence.

The signal produced during rotation of the roller 20 during back-feeding may be used to provide an inhibit signal to prevent any further operation of the machine until the pulses cease. In this way, therefore, the generation of the pulses or groups thereof provides a "dynamic" memory. As compared with conventional strapping machines, the feed-detection is cheaper, faster and considerably more reliable.

The invention has been described in detail in relation to a strapping machine. However, the invention can be applied to other machines in which filamentary or strip material is fed and it is required to use the feed or back-feeding, or the cessation of feeding or back-feeding to control the machine.

Claims

1. A machine for feeding and/or back-feeding filamentary or sheet material comprising a rotary member for effecting such feeding and/or back-feeding; means associated with said rotary member for generating electric pulses, or groups of pulses, as said member rotates and means for detecting the presence and/or absence of said pulses, or groups of pulses, and to provide a signal for the operation of the machine.

2. A machine as claimed in claim 1 comprising a strapping machine for wrapping filamentary material around a package.

3. A machine as claimed in either one of claims 1 or 2 wherein said rotary member is one of a pair of co-operating rotary members and is freely rotatable by engagement with the material to be fed, the other member of the pair being drivable to effect feeding or back-feeding, the arrangement being such that when feeding or back-feeding is completed the one rotary member comes to rest thus providing a signal for the initiation of further operations of the machine.

4. A machine as claimed in claim 3 wherein the rotary members of the or each pair thereof are movable between operative and inoperative positions.

5. A machine as claimed in claim 4 wherein one of said rotary members is mounted on a pivoted arm operated by a solenoid to move the rotary member between an operative position in which the material is gripped between the rotary members and an inoperative position in which the rotary members are spaced apart to give clearance to the material.

6. A machine as claimed in any one of the preceding claims wherein the rotary member is caused to make and break an electrical contact as it rotates to generate the electric pulses or groups of pulses.

7. A machine as claimed in any one of claims 1 to 5 wherein the rotary member drives an apertured or slotted member between a light source and a photo-electric cell, the resistance of

the cell being variable dependant on the light allowed to fall on it and thus producing pulses when connected in an electric circuit.

8. A machine as claimed in any one of claims 1 to 5 wherein the rotary member drives a toothed disc for varying the inductance of the gap in an electro-magnetic circuit to which a DC voltage is applied, the inductance variation producing the pulses or groups of pulses.

9. A machine as claimed in any of claims 1 to 5 wherein the rotary member drives a toothed disc which varies the inductance of the gap in an electro-magnetic circuit to which an AC voltage is applied, the inductance variation producing a series of groups of pulses.

10. A machine as claimed in any one of claims of 1 to 5 wherein the rotary member drives a slotted or apertured disc interposed between the plates of a capacitor and which varies the capacitance thereof, an AC voltage being applied to the capacitor to generate a series of groups of pulses.

11. A strapping machine for wrapping filamentary material around a package constructed and arranged substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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